

A REGIONAL STUDY OF LOBLOLLY PINE (*PINUS TAEDA*) PLANTATION DEVELOPMENT DURING THE FIRST 15 YEARS AFTER EARLY COMPLETE WOODY AND/OR HERBACEOUS PLANT CONTROL

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Introduction

Conifer plantations in North America and elsewhere in the world are increasingly cultured using early control of herbaceous and woody plants. Development of sustainable cultural practices are hindered by the absence of long-term data on productivity gains relative to competition levels, crop-competition dynamics, and ecological changes. There are many reports of early increased growth of loblolly pine (*Pinus taeda* L.) plantations after early competition control, however there are few reported long-term outcomes after stand closure (Clason 1989, Haywood and Tiarks 1990, Glover and Zutter 1993, Jokela et al. 2000). In fact, some longer-term research reports have found no gains but do not state competition levels (Haywood and Tiarks 1990 and Jokela et al. 2000). To understand how sustainable productivity is influenced by site characteristics and competition dynamics, it is necessary to examine both pine and associated plants from many locations established using the same study protocol. To gain a needed regional perspective, strategically located study sites with a range of competition components and soils are required. Such data and patterns to year 15 are presented for 13 study locations established across the southeastern region USA.

Materials

To gain needed baseline data, this study examined loblolly pine plantations grown with early near-complete control (for the first 3-5 years) of hardwoods and shrubs (Woody Control), herbaceous plants (Herb Control), and woody and herbaceous competitors (W+H Control), compared to no control plots. Each site used the same 2x2 factorial design, 4-5 replications per site, and uniform experimental procedures, which permitted comparisons among sites. Genetically improved seedlings were planted on 2.7 x 2.7-m spacings. Annual measurements to year 11 and then at year 15 of pine dimensions permitted examination of accumulative, current (and periodic) and mean annual increments. Hardwood and shrub dimensions were measured with this same schedule, also including cover estimates of woody and herbaceous components. Genera of herbaceous plants were recorded with their cover. Rainfall data for the study period were obtained from the nearest weather station to each site.

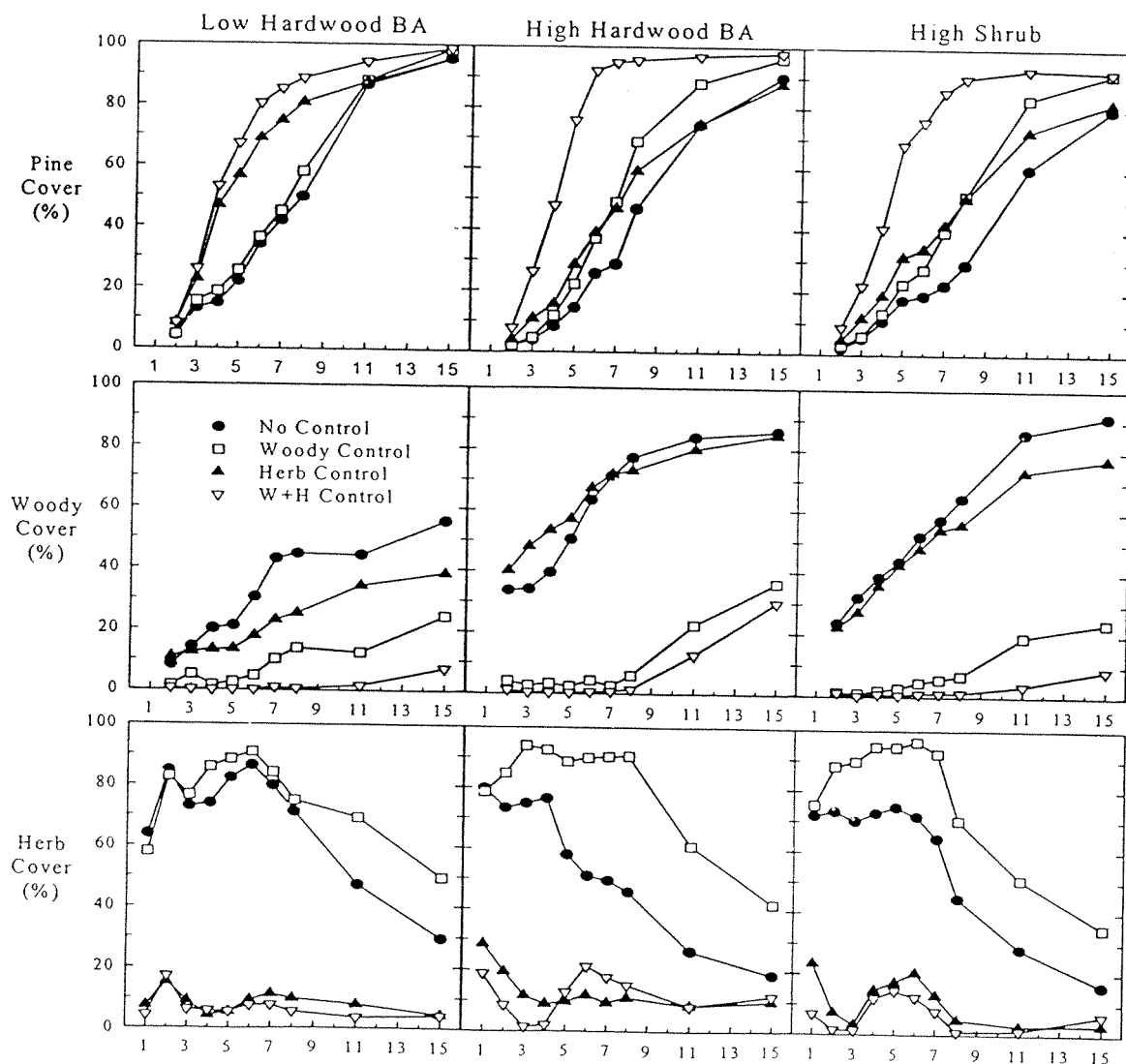
To aid in summarization and interpretation, locations were grouped into woody competition categories. Groupings were developed using Cluster Analysis based on year-15 hardwood basal area (BA) and shrub sum of rootstock heights. Three woody competition categories clearly delineated were: Low Hardwood BA (4 locations), High Hardwood BA (7 locations), and High Shrub (2 locations). High Shrub forests are unique to the Lower Coastal Plain.

Results and Discussion

After 15 years, pine and competition dynamics remained significantly altered by early control treatments and were most influenced by the amounts of hardwoods and shrubs present or controlled. Early woody control significantly ($P < 0.05$) increased 15-year pine merchantable volume on 11 sites by 14-118%, while early herbaceous control increased volume on 10 sites by 4-50%. Gains with the control of both components were generally additive. Pine volume was decreased by about 1.4-1.7% for each percent of hardwood BA present at age 15 as determined by regression analysis. Pine survival was mostly unrelated to control treatments.

Woody control initially increased herbaceous cover (Fig. 1). Herb control alone released not only the pines but also the hardwoods to grow faster resulting in significantly more woody cover by year 8 (Miller et al. 1995). With Herb Control, hardwood BA increased on average by 28%, but not rootstock numbers, while shrubs decreased. Hardwoods remained midstory to understory in stature on all treatments through 15 years. Herb cover declined on all treatments with mid- and overstory canopy closure. Associated flora in these plantations included 139 genera of herbaceous plants, 33 species of shrubs, and 68 species of trees. This is a richer flora than widely acknowledged by plantation opponents (Miller et al. 1995).

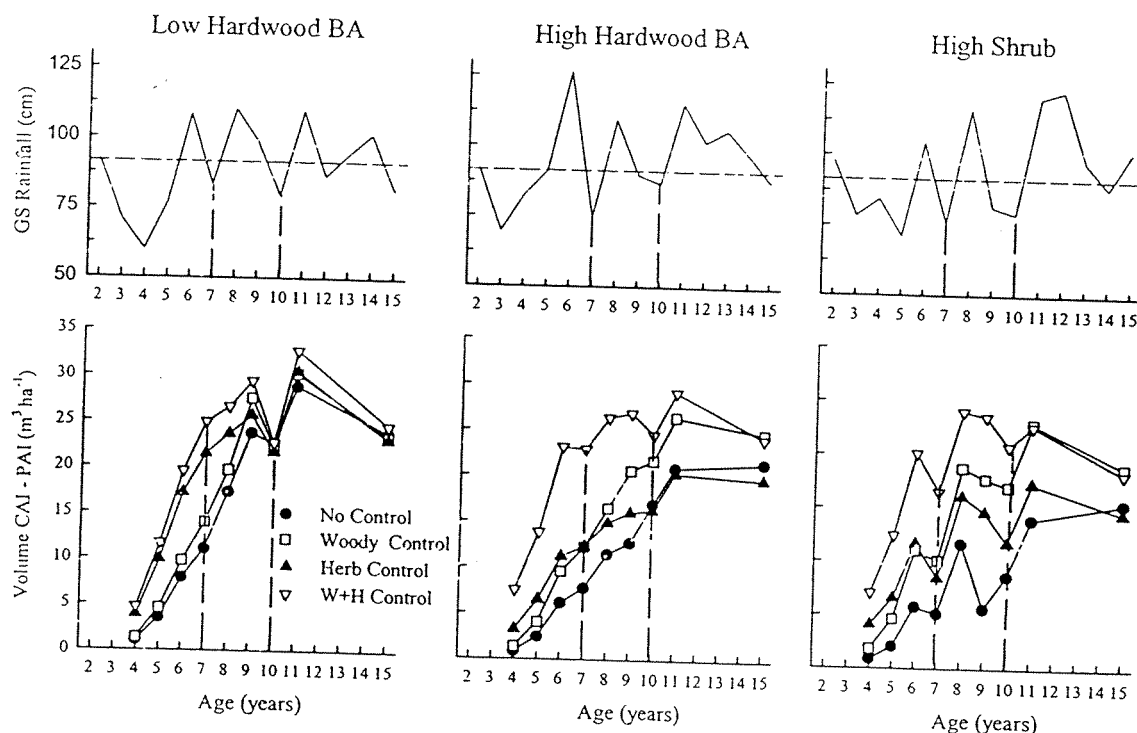
Figure 1. Cover Dynamics for First 15 Years



Contrary to prior reports and the widespread assumption that hardwoods out compete pines (Glover and Zutter 1993), the hardwood proportion of stand BA decreased from years 5 to 15 when hardwood BA in year 5 exceeded $1 \text{ m}^2 \text{ ha}^{-1}$. The difference in outcomes is probably due to hardwood canopy position of whether midstory or overstory.

Culmination of current annual increment (CAI) with woody and herb control (W+H Control) occurred in years 8-11 at $17\text{-}33 \text{ m}^3 \text{ ha}^{-1} \text{ yr}^{-1}$ (Fig. 2). CAI's for pine height, BA, and volume were decreased by about 5-27% when growing season rainfall (Mar-Oct) was less than 92 cm. Rainfall was less influential on CAI during the accelerated juvenile growth phase through year 8 on most sites. Mean annual increment (MAI) had not culminated by year 15 for any treatment at any location, with W+H Control MAI's averaging $14\text{-}17 \text{ m}^3 \text{ ha}^{-1} \text{ yr}^{-1}$.

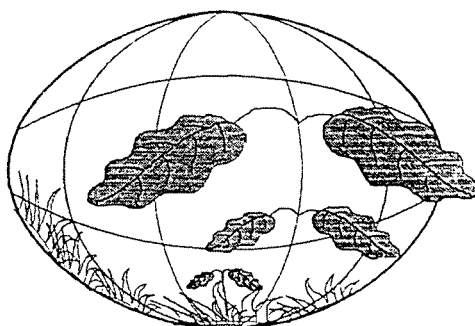
Figure 2. Growing Season Rainfall and Current (and Periodic) Annual Increment



Patterns of plantation stand development and succession remain significantly altered through 15 years after competition control treatments in the first 3-5 years and have been influenced most by the amounts of hardwoods and shrubs present or eliminated. Patterns of stand component development differed among sites with low hardwoods, high hardwoods, and high shrubs. Herb control yielded larger increases in pine volume on low hardwood sites than did woody control treatments, which yielded larger growth gains on high hardwood and shrub locations. The period of stimulated growth gains from early control was in the first 8 years. Enhanced herb cover with woody control likely maintains higher levels of plant diversity.

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